region of cirrus clouds had become greatly intensified. We may infer that that circulation depends, at least, in part on the differences of temperature at different latitudes, because the winds are strongest in the winter, when the difference of temperature between the tropics and the pole is greatest; but we cannot yet describe the mechanism of the process nor the variations from year to year. On the other hand, rainfall seems to have to do rather with the small variations of pressure, which elsewhere I have called the embroidery of the barogram, than with the main features of the barogram. Considerations of space prevent my pursuing here the suggestions that this proposition entails. I need hardly say that the subject is not exhausted by what I have said. W. N. SHAW.

November 27.

The Inheritance of Mental Characters.

MR. WALKER sent me, before publication, the letter which appeared in NATURE of November 23. In reply I explained that, though I have insisted elsewhere that the words *inborn, acquired,* and *inheritable* are often incorrectly used, yet in my paper to the Eugenics Education Society I did not define the meanings of them, partly because my space was limited and partly because I thought no misapprehension could arise in the minds of my audience. None did arise. But I learn, with surprise, that some would have arisen had my critic been present. I used the words exactly as they are commonly used in biological literature, terming such characters as heads and instincts inborn and inheritable, and such characters as scars and a knowledge of Latin acquired.

In Mr. Walker's book, "Hereditary Characters," he was good enough to reproduce many of my conclusions almost in my own words; for example, "In considering the mental characters of man we are forced to the conclusion that almost all are acquirements, and that very little besides consciousness, memory, capacities for making various acquirements, and a few instincts is inborn." This is precisely my opinion as elaborately set forth, not only "on all previous occasions," but in the very paper he criticises. The astounding thing is that he should imagine that it is, or may be, also the opinion of Prof. Karl Pearson, whose statement, he thinks, "may be loosely expressed and open to misinterpretation," but "which does not appear, on the face of it, to be at variance with his own views." I fear Prof. Pearson will pray ardently to be delivered from his friends.

I must complain that the sentence Mr. Walker quotes from my paper is, in the absence of its context, open to misinterpretation. I was not merely railing. The following is the passage from which it is taken. Prof. Pearson does not use the word "inborn"; but if the word "inheritable" or "physical" be substituted for it, my meaning is unaltered

". . . Here we have an example of a conclusion based, like many more of the conclusions of biometricians, on an ascertained correlation. It is assumed that, since offspring reproduce parental mental characters in the same degree as their physical characters, therefore, if the latter are inborn, the former must be inborn also. In other words, it is assumed that one kind of sameness necessarily involves another and a different kind of sameness."

Now, though I have collected no family histories bearing on the subject, I think that no one will deny that such characters as heads, hearts, lungs, livers, and the like are inborn and invariably present in parents and offspring—at any rate in offspring that reach school age. Here we have absolute certainty of inheritance. Again, I think no one will deny that parental birth-marks, moles, and the like, are also inborn, and that they are hardly ever, if ever, reproduced by offspring. Here the degree of inheritability is zero. Between these extremes of inheritability lie the degrees of inheritability of all the other characters. Some, like ten fingers and ten toes, are reproduced almost as certainly as heads; others, like eye-colour and hair texture, with less certainty; others with still less certainty; and so on, and so on, until we reach characters the inheritability of which is scarcely greater than that of birth-marks and moles. Plainly, then, since the inheritance of inborn characters varies between certainty and zero, Pearson's statement is without significance—void of all content. Founded with such an air of scientific accuracy on statistics and family histories which have such an appearance of scientific precision, it is so vague as to be quite nonsensical. By the use of his method any character you like may be "proved" to be inborn; for, if only you seek conscientiously, you will be sure to find another undoubtedly inborn, which is reproduced by offspring in about the same degree. Thus all English children have heads, and all speak English. If, then, you are satisfied with the method, you may conclude that English speech in English children is "bred, not created." Or, alternatively, that English children acquire their heads—for you are happy in always having these alternatives to choose from.

G. ARCHDALL REID.

Southsea, November 26.

Amedeo Avogadro.

EXACTLY a century has passed away since the eminent Italian physicist Avogadro published the law which, bearing his name, is now familiar to every elementary student of chemistry or physics. Owing to various causes, Avogadro's labours were but little appreciated, and though he occupied a foremost position among Italian men of science the scientific world in general evinced but little interest in his work. Even the indefatigable Kopp failed to realise the importance of his speculations, with the result that his first history of chemistry contained no reference at all to them. Like Carnot's, Avogadro's writings had to await an interpreter and supporter. In this respect, however, fortune proved more than kind, and in his countryman Cannizzaro, Avogadro obtained an illustrious disciple and a brilliant exponent of his doctrine. But while it is true that the name of Avogadro is now widely known, it is no less true that the record of his life seems to have escaped biographers and historians alike, a statement which will be substantiated by a search through the ordinary English works of reference.

Count Amedeo Avogadro di Quaregna came of a distinguished and noble family of Biella, a small town some way north of Turin, in Piedmont. Various members of the family had won fame in the courts or on the field, but the name is unknown to the world at large except through the work of this student of physical science. Amedeo's father, Count Filippo, married Anna Vercellone, of Biella, and on August 9, 1776, their son was born at Turin, the birthplace of Lagrange. In obedience to his father's wishes young Avogadro studied law. He received his diploma on March 16, 1796, and during the next few years occupied positions in various branches of the law offices. In April, 1801, he was appointed secretary to the Prefecture of the Eridano province. His natural inclination for mathematics and physics, however, led him to carry on his studies, and with his brother Felice he wrote, and presented to the Academy of Sciences of Turin, two papers, in 1803 and 1804, the first being on electricity and the second on the nature of metallic salts. For this work the brothers were nominated corresponding members of the academy on July 5, 1804. Amedeo now obtained permission from his father to follow the career of his own choosing, and after a short course of study he became in 1806 a demonstrator at the Royal College of the Provinces. Three years later, on November 7, 1809, he was appointed professor of positive philosophy (physics and mathematics) in the Lyceum at Vercelli, where he remained until 1821. It was during the early years of his residence at Vercelli that he produced the two memoirs which have immortalised his name. Both the memoirs were published in the *Journal de Physique* of De la Methérie. The first, which appeared in 1811, was entitled "Essai d'une manière de déterminer les masses relatives des molécules élémentaires des corps, et les proportions selon lesquelles elles entrent dans ce combinaison"; the second appeared in 1814, and was entitled "Mémoire sur les masses relatives des corps simples, ou densités présumées de leur gaz," &c. Avogadro returned to the same subject in a memoir which he published in 1821, 1826, and in 1849, and he investigated other problems bearing on the same subject. His other researches included questions in electricity, chemistry, electrochemistry specific heat, and the expansion of bodies.

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On October 6, 1821, Victor Emmanuel I. instituted the first Italian public chair of higher physics, and in November Avogadro was appointed to it. Owing to political troubles the post was suppressed two years later, and Avogadro, after a brief interval, was given a post at the Regia Camera dei Conti, where he continued with undiminished activity his cherished studies. In January, 1832, Carlo Alberto restored the chair Avogadro had occupied, but appointed to it the famous Cauchy, who, it will be remembered, had been compelled to leave the Collège de France and his seat in the National Institute of France owing to the Revolution of 1830. Cauchy had been elected, amidst a storm of indignation, to the seat in the institute vacant by the expulsion of Monge, and he was now in his turn suffering the vicissitudes of fickle fortune.

Towards the end of 1833 Cauchy left Turin to take charge of the education of the young princes at Prague, and Avogadro was again appointed to the position for which he was so well fitted. He remained professor of physics until 1850, when he resigned owing to advancing age, and was succeeded by his favourite pupil, Felice Chiò. His scientific work was continued almost to the end of his life; and he died at Turin on July 9, 1856, having nearly reached the age of eighty.

Avogadro's memoirs, numbering some forty or fifty, appeared in the *Journal de Physique*, the *Annales de Chimie et de Physique*, *Brugnatelli's Journal*, and other periodicals. Among his works was a huge compilation of 3700 pages, in four volumes, on physics, which was published at the expense of Carlo Alberto. His principal studies, as we have seen, related to the physical properties and the internal structure of bodies, and the law—that equal volumes of gas contain the same number of molecules—to which his name is attached perpetuates his memory. Ampère independently enunciated the same doctrine; but in point of priority Avogadro's claim is beyond dispute.

He was a man esteemed in private life for his kindness, affability, and sincerity. His habits were noted for their simplicity, and he was as modest as he was learned. The year following his death a marble bust in his honour was placed in the University of Turin. In the Scuola Professionale at Biella is another bust, with the inscription—

> I GAS A PARI CONDIZIONI
> DI PRESSIONE E DI TEMPERATURA
> IN EGUALI VOLUMI CONTENGONO
> UN EGUAL NUMERO DI MOLECOLE.

Last year a project was formed to celebrate the centenary of the enunciation of his law, but I do not know whether the scheme was carried through or not.[1] The above details have been obtained from the short biography of Avogadro by Alfonso Cossa, for a copy of which I am indebted to the kindness of Prof. Naccari, the present occupant of the chair of physics at Turin.

EDGAR C. SMITH.

Hong Kong, October 23.

Characteristic Röntgen Radiations.

IN the September number of *The Philosophical Magazine* there appears a paper by Prof. Barkla, in which are tabulated the results of some further experiments on characteristic (fluorescent) Röntgen radiations. It appears that some of the elements of high atomic weight give "two lines in the fluorescent spectrum." Optical analogy suggests that there may be some simple relation connecting these spectral lines. Such a relation can, indeed, be readily obtained, and I should like to be allowed to direct attention to it.

In a paper on the production of characteristic Röntgen rays (Roy. Soc. Proc., 1911), I showed that for the elements from Al upwards (which gave characteristic rays in series K) the radiation they emitted could be defined, indirectly, in terms of their atomic weight. It was shown that the radiation characteristic of an element of atomic weight w is the same (when tested by penetrating power) as the most penetrating of the Röntgen rays emitted from an anti-kathode bombarded by kathode rays of velocity equal to kw, where $k=10^8$.

Thus the radiation characteristic of Se would be emitted by kathode rays of velocity $7{\cdot}92\times10^9$ cm./sec. ($w=79{\cdot}2$), that characteristic of Cu by kathode rays of velocity $6{\cdot}36\times10^9$ cm./sec. ($w=63{\cdot}6$), and so on. Such kathode rays as would produce a characteristic Röntgen-radiation may be conveniently termed equivalent kathode rays. Thus we can define a radiation the λ/ρ of which is known, in terms of the velocity of the equivalent kathode rays, and so indirectly in terms of the atomic weight.

Prof. Barkla tells us that Bi gives out (in series L) a radiation of very nearly the same penetrating power as that from Se in series K (the actual values of λ/ρ are 19·0 and 18·9). From this it follows that the equivalent velocity for Bi (series L) is the same as for Se (series K), *i.e.* $7{\cdot}92\times10^9$. Thus, if we adopt series K for our standard, we can say that Bi behaves (for series L) as though it were an element of atomic weight 79.

The actual atomic weight of Bi is 208, and it behaves (for series L) as if its atomic weight were $w'=\frac{1}{2}(w-50)=79$; thus the two possible spectral lines for Bi are defined in terms of the two equivalent kathode rays of velocities $2{\cdot}08\times10^{10}$ cm./sec. and $7{\cdot}9\times10^9$ cm./sec.

The expression

$$w'=\tfrac{1}{2}(w-50)$$

holds fairly well over the greater part of the range studied by Prof. Barkla, as the following table shows.

Element	w	w'	λ/ρ (calculated)	λ/ρ (observed)
Sb	120·2	35·1	375	435
I	126·9	38·5	298	306
Ba	137·4	43·7	248	224
W	184·0	67·0	35·0	33
Pt	195·0	72·5	25·5	27·5
Au	197·2	73·6	23·8	25
Pb	207·1	78·6	20·0	20
Bi	208·0	79·0	19·1	19

The calculated values of λ/ρ have been obtained by interpolation of w' in a w, λ/ρ graph.

The observed value of λ/ρ for Sb is almost certainly too high, since in some experiments with Sb (August, 1910, Proc. Camb. Phil. Soc.) I found that the equivalent velocity was about $3{\cdot}6\times10^9$ cm./sec. (compare w' above). The agreement otherwise is as good as could be expected.

In conclusion, formulæ of the type to which attention has just been directed ($w'=A.w+B$) may possibly prove useful to experimental investigators in suggesting new "lines" and indicating where to look for them.

R. WHIDDINGTON.

St. John's College, Cambridge, November 16.

A Suggested Reform in Palæobotany.

IN a paper in the *Annals of Botany* for October (pp. 903–7, text figures) I brought forward conclusive botanical evidence that the Cretaceous fossils from the Amboy Clays of North America, hitherto known as *Ophioglossum granulatum*, Heer, are not only not Ophioglossums, but are not ferns at all, and belong to the widely distinct family of Gymnosperms, in the genus Pinus.

This result, in itself of not much importance, forms the text of a general recommendation to palæobotanists, which is as follows:—In the interests of the sciences of palæobotany, geology, and botany, I "urge that the lists published by palæobotanists should be printed in two forms, and that the names of species of leaves, stems, &c., of which there is a reasonable security of determination, should be differentiated from those in which there is no guarantee at all that the actual nature of the plant has been discovered. Any tri-nomial system is cumbrous; but those who publish on fossil plants might print their names in type of two kinds, which would indicate which species are doubtful. I should like to suggest that, instead of using italics or ordinary capitals as is usual in printing the names of species and genera, such doubtful plant-impressions should be printed in Gothic lettering. This would indicate that our knowledge about them is mediæval—of the Dark Ages—and would further save the inconvenience of tri-nomials, while it would indicate immediately the difference between the established and the doubtful determinations. As information accrued about a

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[1] See NATURE of October 26, p. 557.—ED.

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